02 JAN 2002

FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
112740-395

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
10/019985

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/02021	**21 June 2000**	**02 July 1999**

TITLE OF INVENTION
METHOD AND APPARATUS FOR DETERMINING TONE RINGING FREQUENCY

APPLICANT(S) FOR DO/EO/US
Armin Meisner

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

PCTUS1/REV03

JC13 Rec'd PCT/PTO 02 JAN 2002

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/019985	INTERNATIONAL APPLICATION NO. PCT/DE00/02021	ATTORNEY'S DOCKET NUMBER 112740-395

24. The following fees are submitted:.

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	8 - 20 =	0	x $18.00	**$0.00**	
Independent claims	2 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$890.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL =				**$890.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$890.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$890.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$890.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ______ in the amount of ______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056)
Bell, Boyd & Lloyd LLC
P.O. Box 1135
Chicago, Illinois 60690-1135

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

January 2, 2002
DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Armin Meisner	DOCKET NO.:	112740-395
SERIAL NO:		GROUP ART UNIT:	
FILED:		EXAMINER:	
INTERNATIONAL APPLICATION NO::		PCT/DE00/02021	
INTERNATIONAL FILING DATE		21 June 2000	
INVENTION:	METHOD AND APPARATUS FOR DETERMINING TONE RINGING FREQUENCY		

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR DETERMINING TONE RINGING FREQUENCY

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for determining tone ringing frequency and to a corresponding method for determining tone ringing frequency.

Although it can be applied to any tone ringing signalling operations, the present invention and the problems on which it is based are explained with respect to a tone ringing signalling operation for an interphone.

To ensure fault-free signalling of tone ringing, a tone ringing signalling operation has to meet certain requirements. On the one hand, signalling is required to take place only as from a certain minimum modulation (level condition) and, on the other hand, only in response to excitations in a fixed frequency window (frequency condition).

Satisfying the level condition is generally ensured by hardware, whereas satisfying the frequency condition is a task for the software. Failure to satisfy one or both conditions leads to incorrect ringing signalling (for example, no signalling or late signalling when there is a valid ringing signal, ringing signalling without a ringing voltage, etc.).

Superposed interferences of the AC ringing voltage have a great influence on the correct operation of tone ringing frequency detection. However, detection of frequencies affected by interference is not a trivial problem.

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage.

In Figure 3, the time t is plotted on the x-axis and the tone ringing voltage U_T or the ZC signal ZC is plotted on the y-axis. The tone ringing voltage U_T is, in this case, assumed to be a pure sinusoidal AC voltage (solid line at the top of Figure 3).

To permit tone ringing frequency detection, the rectified tone ringing voltage U_T (broken line at the top of Figure 3) is applied to a comparator (not represented). The output of the comparator is connected to a processor, which processes the ZC signal.

As shown, the comparator carries out a comparison of the rectified tone ringing voltage U_T with a threshold S. Each time the rectified tone ringing voltage U_T passes through this threshold in a rising sense, the ZC signal has a falling edge. With every subsequent zero crossing, the ZC signal has a rising edge. Consequently, a certain hysteresis is built in.

The frequency f of the tone ringing signal is obtained in this simple case as t*= 1/2f, where t* is the time interval between two successive rising or falling edges of the ZC signal.

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal.

As Figure 4 reveals, the pulse duty ratio of the ZC signal is highly variable, depending on the position of the comparator threshold S or signal modulation of the tone ringing signal.

Since, however, to measure the period duration or frequency f, triggering is usually in response to the rising or falling edge of the ZC signal, a determination of the frequency f is possible independently of the pulse duty ratio of the ZC signal.

In actual systems, it must be expected that the tone ringing signal is not a pure sinusoidal oscillation, but has superposed periodic and/or a periodic components. These superposed components become noticeable, in particular, whenever the amplitude of the interference is greater than the hysteresis of the ZC detection circuit.

A measure of the insensitivity to such interferences is the interference immunity to external signals. Superposing of interferences over the ZC signal leads to signal variations which are shown in Figure 5 for an interference-affected ZC signal with a differing pulse duty ratio.

The fastest possible evaluation of such interference-affected ZC signals is not trivial. To determine the fundamental oscillation, the interferences must be ignored. With an unfavorable pulse duty ratio, however, it is no longer possible to distinguish between interference pulses and the useful signal.

Systems which blank out pulses or groups of pulses are known. These have, on the one hand, the disadvantage that additional resources are required (for example, a second time base for the blanking out of the interferences). On the other hand, such systems actually carry out a kind of undersampling of the ZC signal by blanking out certain times. If, in this case, the blanked-out time interval is no longer negligible in comparison with the times to be measured, measuring errors occur.

This is illustrated in Figure 6, which shows errors during the interference suppression of the ZC signal which arise due to simple blanking out of the interferences. The blanked-out time range is shaded gray. T_M designates the measuring interval.

In case a) of Figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is correctly determined.

In case b) of Figure 6, a ZC signal with interferences is obtained; the tone ringing frequency f is correctly determined.

In case c) of Figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is not correctly determined, since parts of the useful signal here are wrongly blanked out. In other words, an invalid signal not affected by interference is wrongly determined as valid.

Consequently, with the known approaches presented above, the fact that reliable interference suppression is not possible in all cases has been found to be disadvantageous.

SUMMARY OF THE INVENTION

The method and apparatus according to the present invention for determining tone ringing frequency have the advantage over the known approaches to a solution that, by contrast with known blanking-out methods, reliable interference suppression is possible in spite of radio-frequency interferences on the ZC signal.

The idea on which the present invention is based is that each time interval between a falling edge and a rising edge of the ZC signal is evaluated and an evaluation start time and an evaluation stop time are determined on the basis of a limit value, the evaluation interval determined in this way being a measure of the frequency sought.

According to a preferred embodiment, a monitoring time window for the frequency determination is defined and the measurement is discontinued if the time measured since the evaluation start time lies outside the monitoring time window.

According to a further embodiment, the time duration limit value is defined as a constant.

According to yet another embodiment, a value which is as great as possible is defined for the time duration limit value, with which the attempt to define the evaluation start time is commenced. This value is reduced in accordance with a predetermined algorithm if no evaluation start time can be defined after a certain time.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows an illustration of an embodiment of the method according to the present invention when applied to an interference-affected ZC signal with differing pulse duty ratio.

Figure 2 shows a state diagram of the embodiment of the method shown in Figure 1.

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage.

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal.

Figure 5 shows an illustration of an interference-affected ZC signal with a differing pulse duty ratio.

Figure 6 shows an illustration of the problem which errors occur during the interference suppression of the ZC signal by simple blanking out of the interferences.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows an illustration of an embodiment of the method according to the present invention when applied to an interference-affected ZC signal with a differing pulse duty ratio.

In the case of this embodiment, individual time ranges are not ignored for the determination of the fundamental wave, but instead all partial events are taken into consideration. This is on the assumption that the interferences which are

superposed on the ZC signal are at a higher frequency than the frequency f to be determined.

In other words, a continuous measurement of the respective time duration between the adjacent rising and falling edges of the ZC signal takes place. The frequency of the fundamental oscillation is then derived from these partial events. This embodiment presupposes that the direction of the edge (falling or rising) of the ZC signal can be successively reversed to produce an interrupt.

The time durations of individual partial measurements m_i, m_j are compared with a predetermined limit value t_g which, in this example, is constant. If the time duration of a partial measurement is greater than the limit value t_g, the start condition is satisfied; i.e. an evaluation start time t_1 is defined, if a measured time duration is greater than or equal to the time duration limit value t_g, the evaluation start time (t_1) being the instant of the subsequent edge. At the same time, the phase position of the ZC input signal is determined ("0" = l(ow) or "1" = h(igh)). In Figures 1a) and 1b), this phase position is "0", and in Figure 1c) it is "1".

The stop condition is the next-but-one long ZC signal cycle with the same phase position. Consequently, an evaluation stop time t_2 is defined if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge.

The timer, or time generator, from which all the times are derived, runs freely after the start condition. The time which the timer requires for running through once must in this case be greater than the monitoring window for the ZC signal, which can be defined by a lower time limit T_u and an upper time limit T_o.

If no further interrupts are detected in this monitoring window, the measuring operation is discontinued and the measuring function is returned to the basic state (i.e., the frequency is very low).

The determination of the frequency f sought takes place on the basis of the measured time difference between the evaluation start time t_1 and the evaluation stop time t_2, where $1/f = t_2 - t_1$.

Expedient parameters for the determination of t_g are, for example:

comparator threshold on (V_{on})	17.5 V
comparator threshold off (V_{off})	6.5 V
minimum frequency (f_{min})	20 Hz
maximum frequency (f_{max})	60 Hz
interfering voltage (U_{ST})	6 V_S
ringing voltage (U_R)	32 V_{eff}

Figure 2 shows a state diagram of the embodiment of the method according to the present invention as shown in Figure 1.

In Figure 2, I designates an initialization routine, in order to put the system into a basic state G. Starting from this basis, the time interval between the adjacent rising and falling edges of the ZC signal is measured, until an interval with t greater than or equal to t_g is found.

Then, the timer is started (START) at an evaluation start time t_1, which is the instant of the subsequent edge.

At the evaluation stop time t_2, when a measured time duration with the same ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge, the timer is stopped again.

The various instances at which a measured time duration is greater than or equal to the time duration limit value t_g are designated here by I, II and III. The left-hand loop is for the case of an L starting phase, the right-hand loop for the case of an H starting phase. The respective loop with the designation 1) refers to either the time condition or the phase condition not being satisfied.

If the measured time interval T is within the allowed time window [T_u, T_o], the frequency f determined from it is valid, and the system reverts to the basic state G. Otherwise, the system reverts to the state I.

Although the present invention was described above on the basis of a preferred exemplary embodiment, it is not restricted to this but can be modified in a variety of ways.

In the case of small measuring ranges, as in the case of the above example, the parameter t_g can be defined as a constant. The time interval of the undisturbed

signal component in the case of the highest valid frequency f_{max} must be greater than t_g. In the case of greater measuring ranges and a constant ZC input signal (i.e., the frequency does not change during the measurement), the measurement can be commenced with the greatest possible t_g. If no start condition is found, the parameter t_g is reduced until a start condition is found.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A method for determining tone ringing frequency, and an apparatus for implementing the method, which includes the steps of: forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold, the ZC signal having a succession of alternately rising and falling edges between two ZC signal values; measuring the respective time duration between the adjacent rising and falling edges of the ZC signal; comparing the measured time durations with a predetermined time duration limit value; defining an evaluation start time if a measured time duration is greater than or equal to the time duration limit value, the evaluation start time being the instant of the subsequent edge; defining an evaluation stop time if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value, the evaluation stop time being the instant of the subsequent edge; and determining the frequency on the basis of the measured time difference between the evaluation start time and the evaluation stop time.

In the claims:

On page 13, cancel lines 1-4, and substitute the following left-hand justified heading therefor:

CLAIMS

Please cancel claims 1-8, without prejudice, and substitute the following claims therefor:

9. A method for determining a tone ringing frequency, the method comprising the steps of:

forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold, the ZC signal having a succession of alternately rising and falling edges between two ZC signal values;

measuring a respective time duration between adjacent rising and falling edges of the ZC signal;

comparing the measured time duration with a predetermined time duration limit value;

defining an evaluation start time if the measured time duration is greater than or equal to the predetermined time duration limit value, the evaluation start time being an instant of a subsequent edge;

defining an evaluation stop time if the measured time duration with an identical ZC signal value to a next-but-one instance is greater than or equal to the time duration limit value, the evaluation stop time being the instant of the subsequent edge; and

determining the tone ringing frequency based on a measured time difference between the evaluation start time and the evaluation stop time.

10. A method for determining a tone ringing frequency as claimed in claim 9, the method further comprising the steps of:

defining a monitoring time window for determining the tone ringing frequency; and

discontinuing time measuring if a time measured since the evaluation start time lies outside the monitoring time window.

11. A method for determining a tone ringing frequency as claimed in claim 9, the method further comprising the step of:

defining the predetermined time duration limit value as a constant.

12. A method for determining a tone ringing frequency as claimed in claim 9, the method further comprising the steps of:

defining a value which is as great as possible as the predetermined time duration limit value, with which an attempt to define the evaluation start time is commenced; and

reducing the predetermined time duration limit value in accordance with a predetermined algorithm if the evaluation start time cannot be defined after a certain time.

13. An apparatus for determining a tone ringing frequency, comprising:

a ZC signal generator for forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold, the ZC signal having a succession of alternately rising and falling edges between two ZC signal values;

a measuring part for measuring a respective time duration between adjacent rising and falling edges of the ZC signal;

a comparison part for comparing the measured time duration with a predetermined time duration limit value;

a defining part for defining an evaluation start time if the measured time duration is greater than or equal to the predetermined time duration limit value, the evaluation start time being an instant of a subsequent edge, and for defining an evaluation stop time if the measured time duration with an identical ZC signal value to a next-but-one instance is greater than or equal to the time duration limit value, the evaluation stop time being the instant of the subsequent edge; and

a frequency-determining part for determining the tone ringing frequency based on a measured time difference between the evaluation start time and evaluation stop time.

14. An apparatus for determining a tone ringing frequency as claimed in claim 13, wherein the defining part further defines a monitoring time window for determining the tone ringing frequency and discontinues time measurement if a time measured since the evaluation start time lies outside the monitoring time window.

15. An apparatus for determining a tone ringing frequency as claimed in claim 13, wherein the predetermined time duration limit value is defined as a constant.

16. An apparatus for determining a tone ringing frequency as claimed in claim 13, wherein the defining part further defines a value which is as great as possible at the time duration limit value, with which an attempt to define the evaluation start time is commenced, the predetermined time duration limit value being reduced in accordance with a predetermined algorithm if the evaluation start time cannot be defined after a certain time.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made**".

In addition, the present amendment cancels original claims 1-8 in favor of new claims 9-16. Claims 9-16 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-8 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§101, 102, 103 or

112. Indeed, the cancellation of claims 1-8 does not constitute an intent on the part of the Applicant to surrender any of the subject matter of claims 1-8.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

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Attorneys for Applicant

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

~~Description~~

SPECIFICATION

~~Device and method for determining tone ringing~~

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR DETERMINING TONE RINGING FREQUENCY

~~PRIOR ART~~

BACKGROUND OF THE INVENTION

The present invention relates to ~~a device~~ an apparatus for determining tone ringing frequency and to a corresponding method for determining tone ringing frequency.

Although it can be applied to any tone ringing signalling operations, the present invention and the problems on which it is based are explained with respect to a tone ringing signalling operation for an interphone.

To ensure fault-free signalling of ~~the~~ tone ringing, a tone ringing signalling operation has to meet certain requirements. On the one hand, signalling is required to take place only as from a certain minimum modulation (level condition) and, on the other hand, only in response to excitations in a fixed frequency window (frequency condition).

Satisfying the level condition is generally ensured by ~~the~~ hardware, whereas satisfying the frequency condition ~~on the other hand~~ is a task for the software. Failure to satisfy one or both conditions leads to incorrect ringing signalling (for example, no signalling or late signalling when there is a valid ringing signal, ringing signalling without a ringing voltage, etc.).

Superposed interferences of the AC ringing voltage have a great influence on the correct operation of tone ringing frequency detection. However, detection of frequencies affected by interference is not a trivial problem.

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage.

In ~~figure~~ Figure 3, the time t is plotted on the x-axis and the tone ringing voltage U_T or the ZC signal ZC is plotted on the y-axis. The tone ringing voltage U_T is, in this case, assumed to be a pure sinusoidal AC voltage (solid line at the top of ~~figure~~ Figure 3).

To permit tone ringing frequency detection, the rectified tone ringing voltage U_T (broken line at the top of ~~figure~~ Figure 3) is applied to a comparator (not represented). The output of the comparator is connected to a processor, which processes the ZC signal.

As shown, the comparator carries out a comparison of the rectified tone ringing voltage U_T with a threshold S. Each time the rectified tone ringing voltage U_T passes through this threshold in a rising sense, the ZC signal has a falling edge. With every subsequent zero crossing, the ZC signal has a rising edge. Consequently, a certain hysteresis is built in.

The frequency f of the tone ringing signal is obtained in this simple case as $t^* = 1/2f$, where t^* is the time interval between two successive rising or falling edges of the ZC signal.

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal.

As ~~figure~~ Figure 4 reveals, the pulse duty ratio of the ZC signal is highly variable, depending on the position of the comparator threshold S or signal modulation of the tone ringing signal.

Since, however, to measure the period duration or frequency f, triggering is usually ~~always~~ in response to the rising or falling edge of the ZC signal, a determination of the frequency f is possible independently of the pulse duty ratio of the ZC signal.

In actual systems, it must be expected that the tone ringing signal is not a pure sinusoidal oscillation, but has superposed periodic and/or a periodic components. These superposed components become noticeable, in particular, whenever the amplitude of the interference is greater than the hysteresis of the ZC detection circuit.

A measure of the insensitivity to such interferences is the interference immunity to external signals. Superposing of interferences over the ZC signal leads to signal variations which are shown in ~~figure~~ Figure 5 for an interference-affected ZC signal with a differing pulse duty ratio.

The fastest possible evaluation of such interference-affected ZC signals is not trivial. To determine the fundamental oscillation, the interferences must be ignored. With an unfavorable pulse duty ratio, however, it is no longer possible to distinguish between interference pulses and the useful signal.

Systems which blank out pulses or groups of pulses are known. These have, on the one hand, the disadvantage that additional resources are required (for example, a second time base for the blanking out of the interferences). On the other hand, such systems actually carry out a kind of undersampling of the ZC signal by blanking out certain times. If, in this case, the blanked-out time interval is no longer negligible in comparison with the times to be measured, measuring errors occur.

This is illustrated in ~~figure~~ Figure 6, which shows errors during the interference suppression of the ZC signal which arise due to simple blanking out of the interferences. The blanked-out time range is shaded gray. T_M designates the measuring interval.

In case a) of ~~figure~~ Figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is correctly determined.

In case b) of ~~figure~~ Figure 6, a ZC signal with interferences is obtained; the tone ringing frequency f is correctly determined.

In case c) of ~~figure~~ Figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is not correctly determined, since ~~here~~ parts of the useful signal here are wrongly blanked out. In other words, an invalid signal not affected by interference is wrongly determined as valid.

Consequently, with the known approaches presented above, the fact that reliable interference suppression is not possible in all cases has been found to be disadvantageous.

~~ADVANTAGES OF THE INVENTION~~

SUMMARY OF THE INVENTION

The method and apparatus according to the present invention for determining tone ringing frequency ~~with the features of claim 1 and the corresponding device for determining tone ringing frequency according to claim 5~~ have the advantage over the known approaches to a solution that, by contrast with known blanking-out methods, reliable interference suppression is possible in spite of radio-frequency interferences on the ZC signal.

The idea on which the present invention is based is that each time interval between a falling edge and a rising edge of the ZC signal is evaluated and an evaluation start time and an evaluation stop time are determined on the basis of a limit value, the evaluation interval determined in this way being a measure of the frequency sought.

~~Advantageous developments and improvements of the relevant subject-matter according to the invention can be found in the subclaims.~~

According to a preferred ~~development~~ embodiment, a monitoring time window for the frequency determination is defined and the measurement is discontinued if the time measured since the evaluation start time lies outside the monitoring time window.

According to a further ~~preferred development~~ embodiment, the time duration limit value is defined as a constant.

According to ~~a further preferred development~~ yet another embodiment, a value which is as great as possible is defined for the time duration limit value, with which the attempt to define the evaluation start time is commenced. This value is reduced in accordance with a predetermined algorithm if no evaluation start time can be defined after a certain time.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

~~DRAWINGS~~

~~Exemplary embodiments of the invention are represented in the drawings and explained in more detail in the description which follows.~~

~~In the drawings:~~

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows an illustration of an embodiment of the method according to the present invention when applied to an interference-affected ZC signal with differing pulse duty ratio.

Figure 2 shows a state diagram of the embodiment of the method ~~according to the invention as~~ shown in ~~figure~~ Figure 1~~;~~.

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage~~;~~.

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal~~;~~.

Figure 5 shows an illustration of an interference-affected ZC signal with a differing pulse duty ratio~~; and~~.

Figure 6 shows an illustration of the problem which errors occur during the interference suppression of the ZC signal by simple blanking out of the interferences.

~~DESCRIPTION OF THE EXEMPLARY EMBODIMENTS~~

DETAILED DESCRIPTION OF THE INVENTION

~~In the figures, the same reference numerals designate components which are the same or functionally the same.~~

Figure 1 shows an illustration of an embodiment of the method according to the present invention when applied to an interference-affected ZC signal with a differing pulse duty ratio.

In the case of this embodiment ~~of the method according to the invention~~, individual time ranges are not ignored for the determination of the fundamental wave, but instead all partial events are taken into consideration. This is on the assumption that the interferences which are superposed on the ZC signal are at a higher frequency than the frequency f to be determined.

In other words, a continuous measurement of the respective time duration between the adjacent rising and falling edges of the ZC signal takes place. The frequency of the fundamental oscillation is then derived from these partial events.

~~The~~ This embodiment presupposes that the direction of the edge (falling or rising) of the ZC signal can be successively reversed to produce an interrupt.

The time durations of individual partial measurements m_i, m_j are compared with a predetermined limit value t_g~~;~~ which, in this example, is constant. If the time duration of a partial measurement is greater than the limit value t_g, the start condition is satisfied~~,~~ ; i.e. an evaluation start time t_1 is defined, if a measured time duration is greater than or equal to the time duration limit value t_g, the evaluation start time (t_1) being the instant of the subsequent edge. At the same time, the phase position of the ZC input signal is determined ("0" = l(ow) or "1" = h(igh)). In ~~figures~~ Figures 1a) and 1b), this phase position is "0", and in ~~figure~~ Figure 1c) it is "1".

The stop condition is the next-but-one long ZC signal cycle with the same phase position. Consequently, an evaluation stop time t_2 is defined if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge.

The timer, or time generator, from which all the times are derived, runs freely after the start condition. The time which the timer requires for running through once must in this case be greater than the monitoring window for the ZC signal, which can be defined by a lower time limit T_u and an upper time limit T_o.

If no further interrupts are detected in this monitoring window, the measuring operation is discontinued and the measuring function is returned to the basic state (i.e., the frequency is very low).

The determination of the frequency f sought takes place on the basis of the measured time difference between the evaluation start time t_1 and the evaluation stop time t_2, where $1/f = t_2 - t_1$.

Expedient parameters for the determination of t_g are, for example:

comparator threshold on (V_{on})	17.5 V
comparator threshold off (V_{off})	6.5 V
minimum frequency (f_{min})	20 Hz
maximum frequency (f_{max})	60 Hz

interfering voltage (U_{ST}) 6 V_S

ringing voltage (U_R) 32 V_{eff}

Figure 2 shows a state diagram of the embodiment of the method according to the present invention as shown in ~~figure~~ Figure 1.

In ~~figure~~ Figure 2, I designates an initialization routine, in order to put the system into a basic state G. Starting from this basis, the time interval between the adjacent rising and falling edges of the ZC signal is measured, until an interval with t greater than or equal to t_g is found.

Then, the timer is started (START) at an evaluation start time t_1, which is the instant of the subsequent edge.

At the evaluation stop time t_2, when a measured time duration with the same ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge, the timer is stopped again.

The various instances at which a measured time duration is greater than or equal to the time duration limit value t_g are designated here by I, II and III. The left-hand loop is for the case of an L starting phase, the right-hand loop for the case of an H starting phase. The respective loop with the designation 1) ~~means that~~ refers to either the time condition or the phase condition ~~is~~ not being satisfied.

If the measured time interval T is within the allowed time window [T_u, T_o], the frequency f determined from it is valid, and the system reverts to the basic state G. Otherwise, the system reverts to the state I.

Although the present invention was described above on the basis of a preferred exemplary embodiment, it is not restricted to this but can be modified in a variety of ways.

In the case of small measuring ranges, as in the case of the above example, the parameter t_g can be defined as a constant. The time interval of the undisturbed signal component in the case of the highest valid frequency f_{max} must be greater than t_g. In the case of greater measuring ranges and a constant ZC input signal (i.e., the frequency does not change during the measurement), the measurement can be

commenced with the greatest possible t_g. If no start condition is found, the parameter t_g is reduced until a start condition is found.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Device and method for determining tone ringing frequency~~

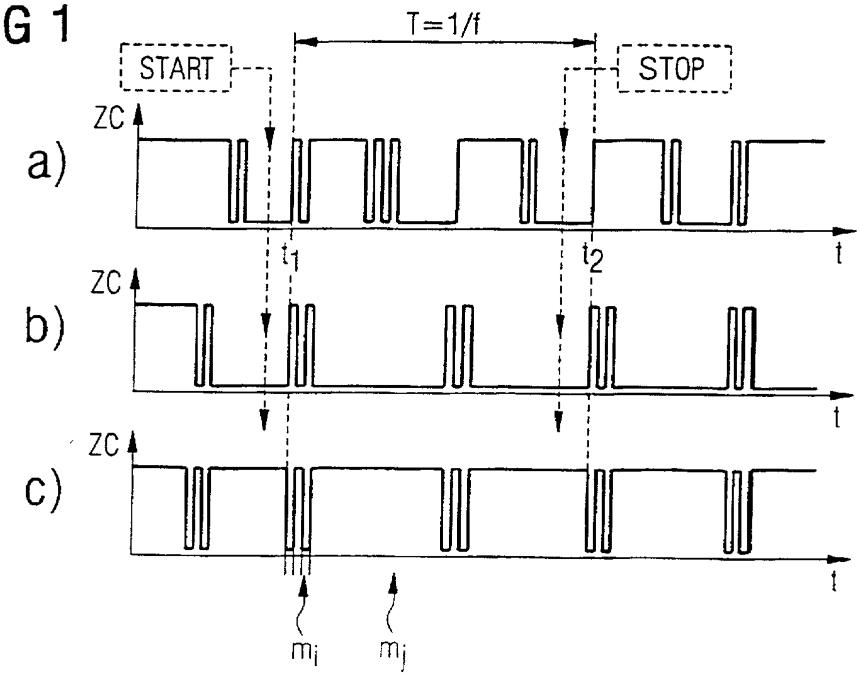
~~ABSTRACT~~

ABSTRACT OF THE DISCLOSURE

~~The invention provides a~~ A method for determining tone ringing frequency, and an apparatus for implementing the method, which includes ~~with~~ the ~~following~~ steps of: forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold ~~(S)~~, the ZC signal having a succession of alternately rising and falling edges between two ZC signal values; measuring the respective time duration between the adjacent rising and falling edges of the ZC signal; comparing the measured time durations with a predetermined time duration limit value ~~(t_g)~~; defining an evaluation start time ~~(t_1)~~ if a measured time duration is greater than or equal to the time duration limit value ~~(t_g)~~, the evaluation start time ~~(t_1)~~ being the instant of the subsequent edge; defining an evaluation stop time ~~(t_2)~~ if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value ~~(t_g)~~, the evaluation stop time ~~(t_2)~~ being the instant of the subsequent edge; and determining the frequency ~~(f)~~ on the basis of the measured time difference between the evaluation start time ~~(t_1)~~ and the evaluation stop time ~~(t_2)~~.

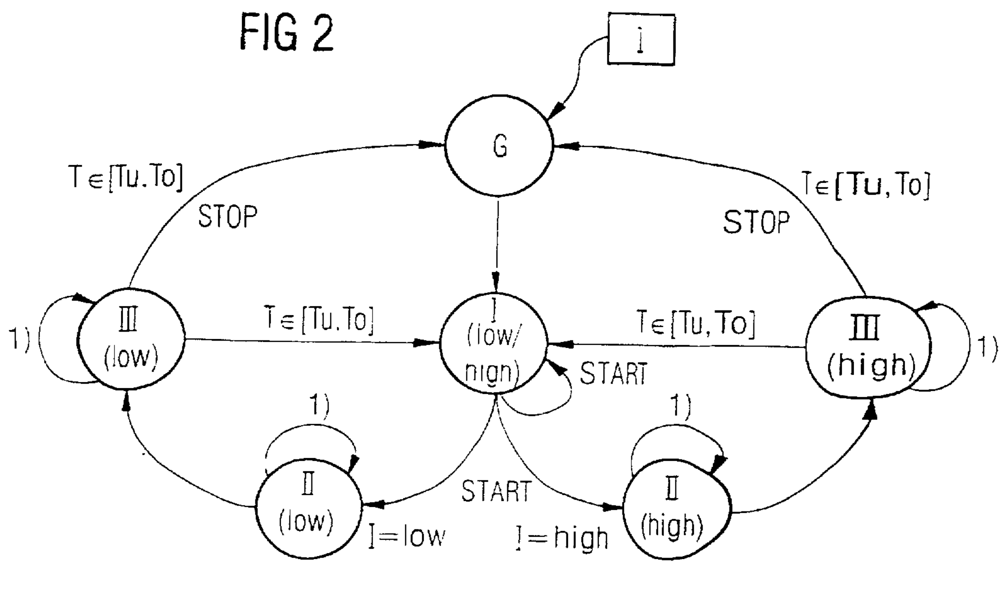
~~(Figure 1)~~

FIG 1



T=1/f
START
STOP
ZC
a)
b)
c)
t_1
t_2
t
m_i
m_j

FIG 2



I
G
T∈[Tu.To]
STOP
T∈[Tu,To]
STOP
III (low)
I (low/ high)
III (high)
START
1)
II (low)
II (high)
START
I=low
I=high

FIG 3

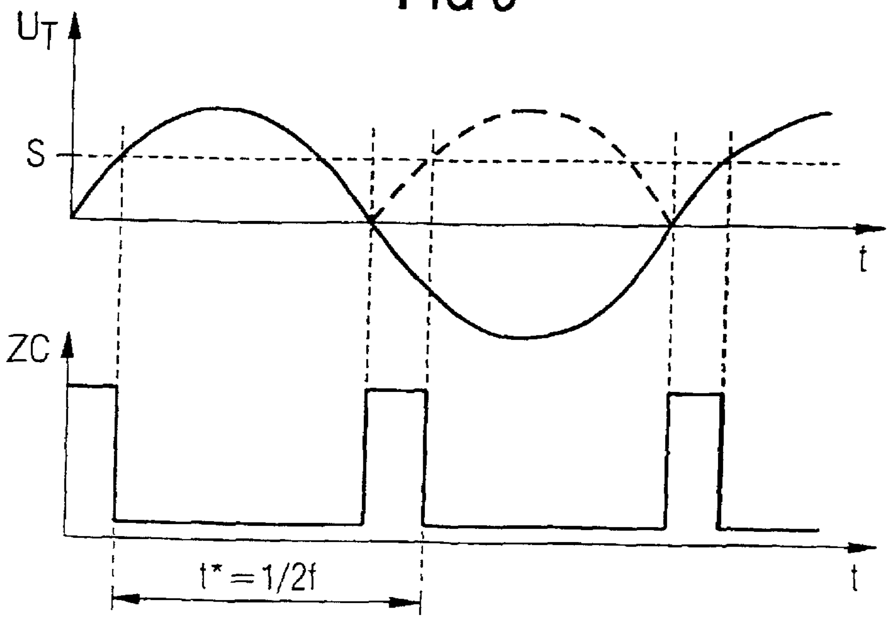


FIG 4

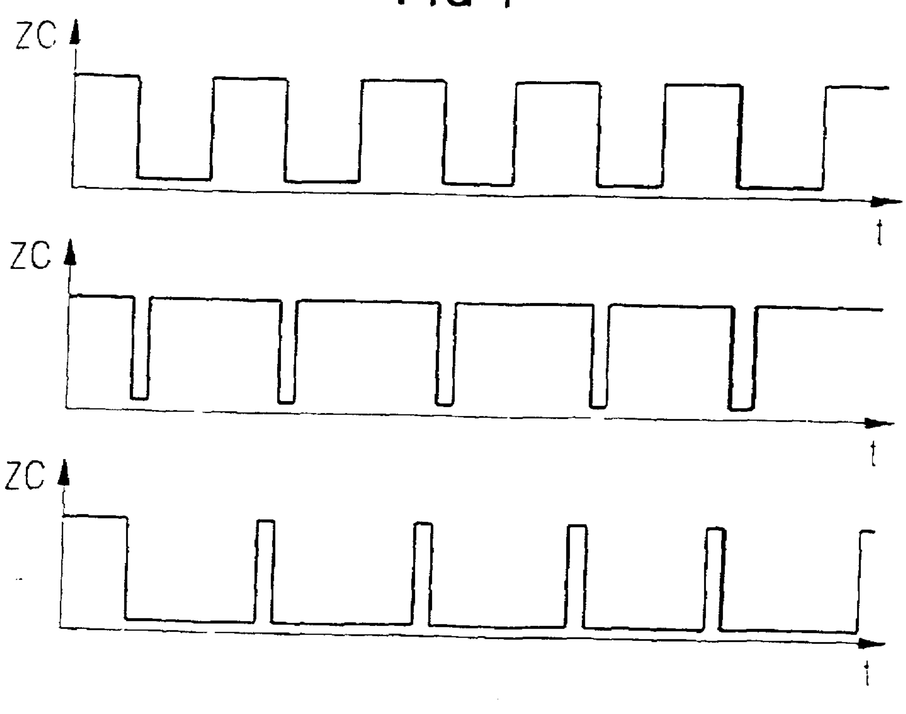


FIG 5

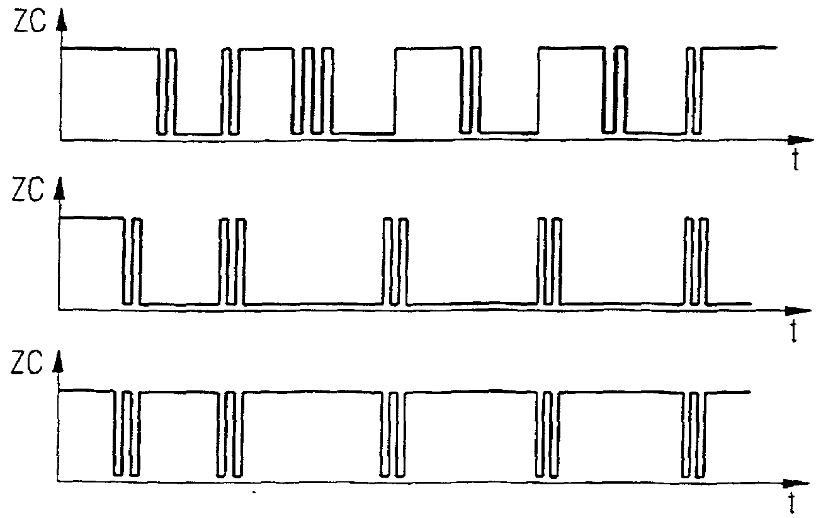
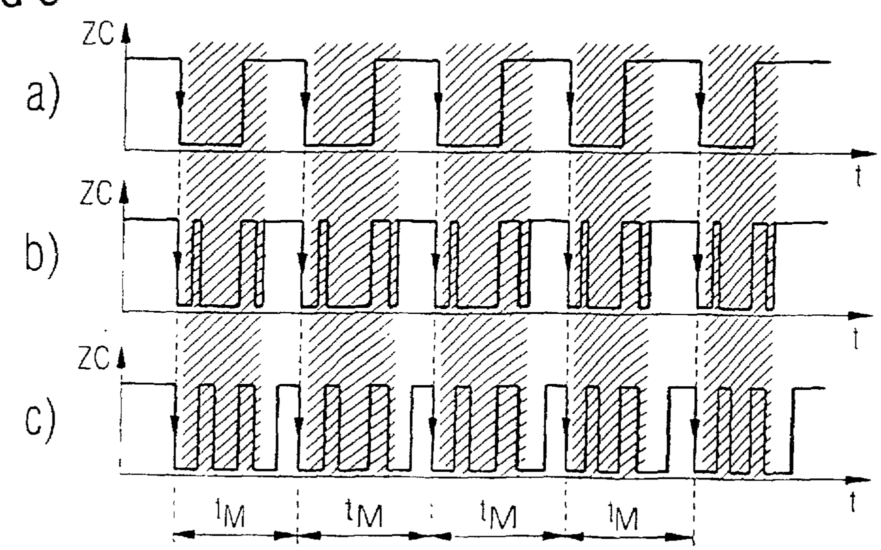


FIG 6



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Device and method for determining tone ringing frequency

PRIOR ART

The present invention relates to a device for determining tone ringing frequency and to a corresponding method for determining tone ringing frequency.

Although it can be applied to any tone ringing signalling operations, the present invention and the problems on which it is based are explained with respect to a tone ringing signalling operation for an interphone.

To ensure fault-free signalling of the tone ringing, a tone ringing signalling operation has to meet certain requirements. On the one hand, signalling is required to take place only as from a certain minimum modulation (level condition), on the other hand only in response to excitations in a fixed frequency window (frequency condition).

Satisfying the level condition is generally ensured by the hardware, satisfying the frequency condition on the other hand is a task for the software. Failure to satisfy one or both conditions leads to incorrect ringing signalling (for example no signalling or late signalling when there is a valid ringing signal, ringing signalling without a ringing voltage,

etc.).

Superposed interferences of the AC ringing voltage have a great influence on the correct operation of tone ringing frequency detection. However, detection of frequencies affected by interference is not a trivial problem.

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage.

In figure 3, the time t is plotted on the x-axis and the tone ringing voltage U_T or the ZC signal ZC is plotted on the y-axis. The tone ringing voltage U_T is in this case assumed to be a pure sinusoidal AC voltage (solid line at the top of figure 3).

To permit tone ringing frequency detection, the rectified tone ringing voltage U_T (broken line at the top of figure 3) is applied to a comparator (not represented). The output of the comparator is connected to a processor, which processes the ZC signal.

As shown, the comparator carries out a comparison of the rectified tone ringing voltage U_T with a threshold S. Each time the rectified tone ringing voltage U_T passes through this threshold in a rising sense, the ZC signal has a falling edge. With every subsequent zero

crossing, the ZC signal has a rising edge. Consequently, a certain hysteresis is built in.

The frequency f of the tone ringing signal is obtained in this simple case as t*= 1/2f, where t* is the time interval between two successive rising or falling edges of the ZC signal.

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal.

As figure 4 reveals, the pulse duty ratio of the ZC signal is highly variable, depending on the position of the comparator threshold S or signal modulation of the tone ringing signal.

Since, however, to measure the period duration or frequency f, triggering is usually always in response to the rising or falling edge of the ZC signal, a determination of the frequency f is possible independently of the pulse duty ratio of the ZC signal.

In actual systems, it must be expected that the tone ringing signal is not a pure sinusoidal oscillation, but has superposed periodic and/or aperiodic components. These superposed components become noticeable in particular whenever the amplitude of the interference is greater than the hysteresis of the ZC detection circuit.

A measure of the insensitivity to such interferences is the interference immunity to external signals. Superposing of interferences over the ZC signal leads to signal variations which are shown in figure 5 for an interference-affected ZC signal with a differing pulse duty ratio.

The fastest possible evaluation of such interference-affected ZC signals is not trivial. To determine the fundamental oscillation, the interferences must be ignored. With an unfavorable pulse duty ratio, however, it is no longer possible to distinguish between interference pulses and the useful signal.

Systems which blank out pulses or groups of pulses are known. These have, on the one hand, the disadvantage that additional resources are required (for example a second time base for the blanking out of the interferences). On the other hand, such systems actually carry out a kind of undersampling of the ZC signal by blanking out certain times. If in this case the blanked-out time interval is no longer negligible in comparison with the times to be measured, measuring errors occur.

This is illustrated in figure 6, which shows errors during the interference suppression of the ZC signal which arise due to simple blanking out of the interferences. The blanked-out time range is shaded gray. T_M designates the measuring interval.

In case a) of figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is correctly determined.

In case b) of figure 6, a ZC signal with interferences is obtained; the tone ringing frequency f is correctly determined.

In case c) of figure 6, a ZC signal without interferences is obtained; the tone ringing frequency f is not correctly determined, since here parts of the useful signal are wrongly blanked out. In other words, an invalid signal not affected by interference is wrongly determined as valid.

Consequently, with the known approaches presented above, the fact that reliable interference suppression is not possible in all cases has been found to be disadvantageous.

ADVANTAGES OF THE INVENTION

The method according to the invention for determining tone ringing frequency with the features of claim 1 and the corresponding device for determining tone ringing frequency according to claim 5 have the advantage over the known approaches to a solution that, by contrast with known blanking-out methods, reliable interference suppression is possible in spite of radio-frequency interferences on the ZC signal.

The idea on which the present invention is based is that each time interval between a falling edge and a rising edge of the ZC signal is evaluated and an evaluation start time and an evaluation stop time are determined on the basis of a limit value, the

evaluation interval determined in this way being a measure of the frequency sought.

Advantageous developments and improvements of the relevant subject-matter according to the invention can be found in the subclaims.

According to a preferred development, a monitoring time window for the frequency determination is defined and the measurement is discontinued if the time measured since the evaluation start time lies outside the monitoring time window.

According to a further preferred development, the time duration limit value is defined as a constant.

According to a further preferred development, a value which is as great as possible is defined for the time duration limit value, with which the attempt to define the evaluation start time is commenced. This value is reduced in accordance with a predetermined algorithm if no evaluation start time can be defined after a certain time.

DRAWINGS

Exemplary embodiments of the invention are represented in the drawings and explained in more detail in the description which follows.

In the drawings:

Figure 1 shows an illustration of an embodiment of the method according to the invention when applied to an interference-affected ZC signal with differing pulse duty ratio;

Figure 2 shows a state diagram of the embodiment of the method according to the invention as shown in figure 1;

Figure 3 shows an illustration of how a ZC signal (ZC = Zero Crossing) is derived from the sensed tone ringing voltage;

Figure 4 shows an illustration of a ZC signal without interference, with a differing amplitude of the tone ringing signal;

Figure 5 shows an illustration of an interference-affected ZC signal with a differing pulse duty ratio; and

Figure 6 shows an illustration of the problem which errors occur during the interference suppression of the ZC signal by simple blanking out of the interferences.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

In the figures, the same reference numerals designate components which are the same or functionally the same.

Figure 1 shows an illustration of an embodiment of the method according to the invention when applied to an interference-affected ZC signal with a differing pulse duty ratio.

In the case of this embodiment of the method according to the invention, individual time ranges are not ignored for the determination of the fundamental wave, but instead all partial events are taken into consideration. This is on the assumption that the interferences which are superposed on the ZC signal are at a higher frequency than the frequency f to be determined.

In other words, a continuous measurement of the respective time duration between the adjacent rising and falling edges of the ZC signal takes place. The frequency of the fundamental oscillation is then derived from these partial events. The embodiment presupposes that the direction of the edge (falling or rising) of the ZC signal can be successively reversed to produce an interrupt.

The time durations of individual partial measurements m_i, m_j are compared with a predetermined limit value t_g, which in this example is constant. If the time duration of a partial measurement is greater than the limit value t_g, the start condition is satisfied, i.e. an evaluation start time t_1 is defined,

if a measured time duration is greater than or equal to the time duration limit value t_g, the evaluation start time (t_1) being the instant of the subsequent edge. At the same time, the phase position of the ZC input signal is determined ("0" = l(ow) or "1" = h(igh)). In figures 1a) and 1b), this phase position is "0", and in figure 1c) it is "1".

The stop condition is the next-but-one long ZC signal cycle with the same phase position. Consequently, an evaluation stop time t_2 is defined if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge.

The timer, or time generator, from which all the times are derived runs freely after the start condition. The time which the timer requires for running through once must in this case be greater than the monitoring window for the ZC signal, which can be defined by a lower time limit T_u and an upper time limit T_o.

If no further interrupts are detected in this monitoring window, the measuring operation is discontinued and the measuring function is returned to the basic state (i.e. the frequency is very low).

The determination of the frequency f sought takes place on the basis of the measured time difference between the evaluation start time t_1 and the evaluation stop time t_2, where $1/f = t_2 - t_1$.

Expedient parameters for the determination of t_g are, for example:

comparator threshold on (V_{on})	17.5 V
comparator threshold off (V_{off})	6.5 V
minimum frequency (f_{min})	20 Hz
maximum frequency (f_{max})	60 Hz
interfering voltage (U_{ST})	6 V_S
ringing voltage (U_R)	32 V_{eff}

Figure 2 shows a state diagram of the embodiment of the method according to the invention as shown in figure 1.

In figure 2, I designates an initialization routine, in order to put the system into a basic state G. Starting from this basis, the time interval between the adjacent rising and falling edges of the ZC signal is measured, until an interval with t greater than or equal to t_g is found.

Then, the timer is started (START) at an evaluation start time t_1, which is the instant of the subsequent edge.

At the evaluation stop time t_2, when a measured time duration with the same ZC signal value to the next-but-one instance is greater than or

equal to the time duration limit value t_g, the evaluation stop time t_2 being the instant of the subsequent edge, the timer is stopped again.

The various instances at which a measured time duration is greater than or equal to the time duration limit value t_g are designated here by I, II and III. The left-hand loop is for the case of an L starting phase, the right-hand loop for the case of an H starting phase. The respective loop with the designation 1) means that either the time condition or the phase condition is not satisfied.

If the measured time interval T is within the allowed time window $[T_u, T_o]$, the frequency f determined from it is valid, and the system reverts to the basic state G. Otherwise, the system reverts to the state I.

Although the present invention was described above on the basis of a preferred exemplary embodiment, it is not restricted to this but can be modified in a variety of ways.

In the case of small measuring ranges, as in the case of the above example, the parameter t_g can be defined as a constant. The time interval of the undisturbed signal component in the case of the highest valid frequency f_{max} must be greater than t_g. In the case of greater measuring ranges and a constant ZC input signal (i.e. the frequency does not change during the measurement), the measurement can be commenced with the greatest possible t_g. If no

start condition is found, the parameter t_g is reduced until a start condition is found.

Device and method for determining tone ringing frequency

PATENT CLAIMS

1. A method for determining tone ringing frequency, with the following steps:

forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold (S), the ZC signal having a succession of alternately rising and falling edges between two ZC signal values;

measuring the respective time duration between the adjacent rising and falling edges of the ZC signal;

comparing the measured time durations with a predetermined time duration limit value (t_g);

defining an evaluation start time (t_1) if a measured time duration is greater than or equal to the time duration limit value (t_g), the evaluation start time (t_1) being the instant of the subsequent edge;

defining an evaluation stop time (t_2) if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value (t_g),

the evaluation stop time (t_2) being the instant of the subsequent edge; and

determining the frequency (f) on the basis of the measured time difference between the evaluation start time (t_1) and the evaluation stop time (t_2).

2. The method for determining tone ringing frequency as claimed in claim 1, characterized by the following steps:

defining a monitoring time window (T_u, T_o) for the frequency determination; and

discontinuing the measurement if the time measured since the evaluation start time (t_1) lies outside the monitoring time window.

3. The method for determining tone ringing frequency as claimed in one of the preceding claims, characterized in that the time duration limit value (t_g) is defined as a constant.

4. The method for determining tone ringing frequency as claimed in either of claims 1 and 2, characterized in that a value which is as great as possible is defined for the time duration limit value (t_g), with which the attempt to define the evaluation start time (t_1) is commenced; and this value is reduced in accordance with a predetermined algorithm if no evaluation start time (t_1) can be defined after a certain time.

5. A device for determining tone ringing frequency, with:

a ZC signal generating means for forming a ZC signal from a tone ringing signal by comparing the tone ringing signal with a threshold (S), the ZC signal having a succession of alternately rising and falling edges between two ZC signal values;

a measuring means for measuring the respective time duration between the adjacent rising and falling edges of the ZC signal;

a comparison means for comparing the measured time durations with a predetermined time duration limit value (t_g);

a defining means for defining

i) an evaluation start time (t_1) if a measured time duration is greater than or equal to the time duration limit value (t_g), the evaluation start time (t_1) being the instant of the subsequent edge;

ii) defining an evaluation stop time (t_2) if a measured time duration with an identical ZC signal value to the next-but-one instance is greater than or equal to the time duration limit value (t_g), the evaluation stop time (t_2) being the instant of the subsequent edge; and

a frequency-determining means for determining the frequency (f) on the basis of the measured time difference between the evaluation start time (t_1) and the evaluation stop time (t_2).

6. The device for determining tone ringing frequency as claimed in claim 5, characterized in that the defining means for defining a monitoring time window (T_u, T_o) is designed for the frequency determination and for discontinuing the measurement if the time measured since the evaluation start time (t_1) lies outside the monitoring time window.

7. The device for determining tone ringing frequency as claimed in either of the preceding claims 5 and 6, characterized in that the defining means defines the time duration limit value (t_g) as a constant.

8. The device for determining tone ringing frequency as claimed in either of claims 5 and 6, characterized in that the defining means defines a value which is as great as possible for the time duration limit value (t_g), with which the attempt to define the evaluation start time (t_1) is commenced; and this value can be reduced in accordance with a predetermined algorithm if no evaluation start time (t_1) can be defined after a certain time.

FIG 1

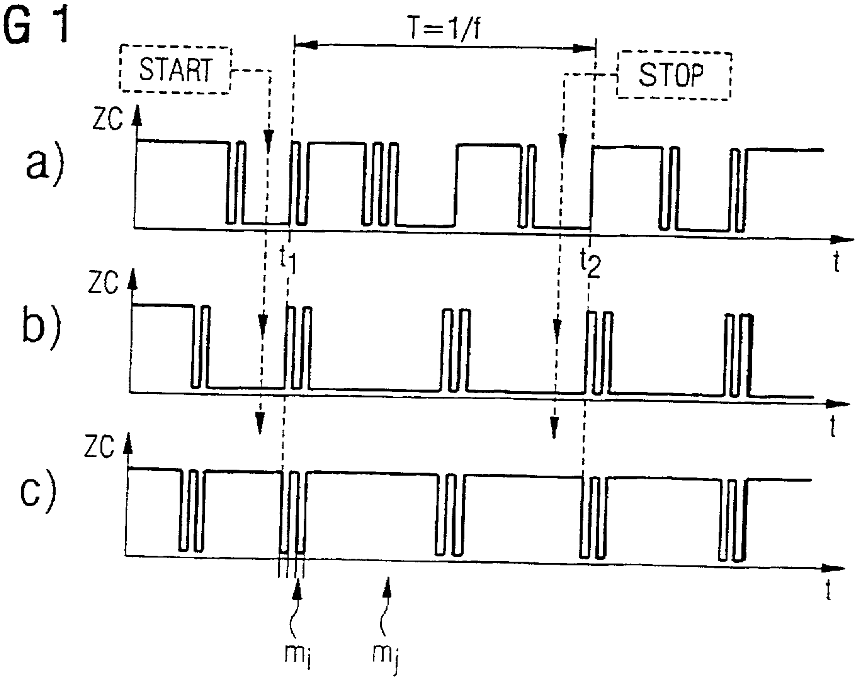

T=1/f
START
STOP
ZC
a)
t_1
t_2
t
ZC
b)
t
ZC
c)
t
m_i
m_j

FIG 2

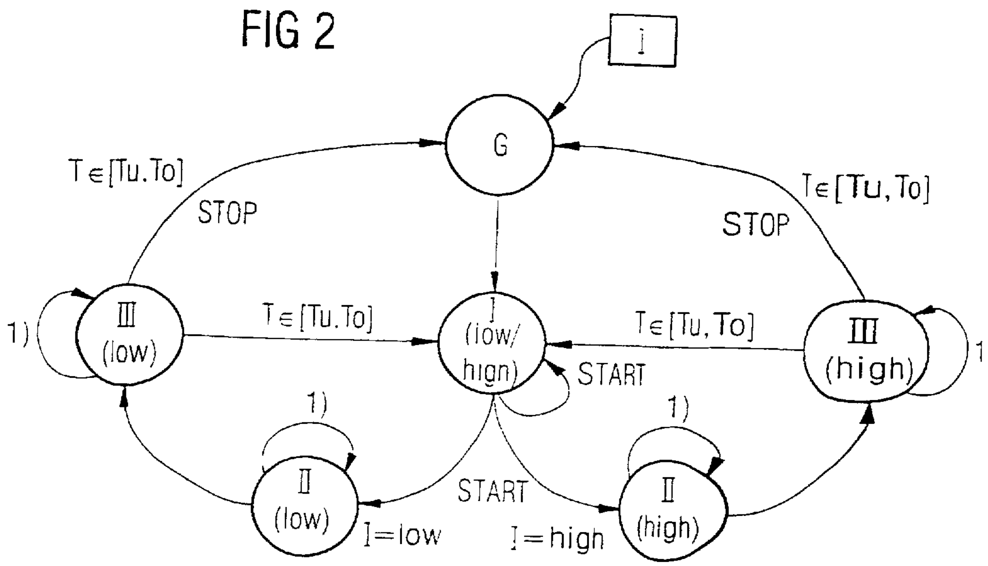

I
G
T∈[Tu,To]
STOP
T∈[Tu,To]
STOP
III
(low)
1)
T∈[Tu,To]
I
(low/
high)
T∈[Tu,To]
START
III
(high)
1)
1)
II
(low)
I=low
START
I=high
1)
II
(high)

FIG 3

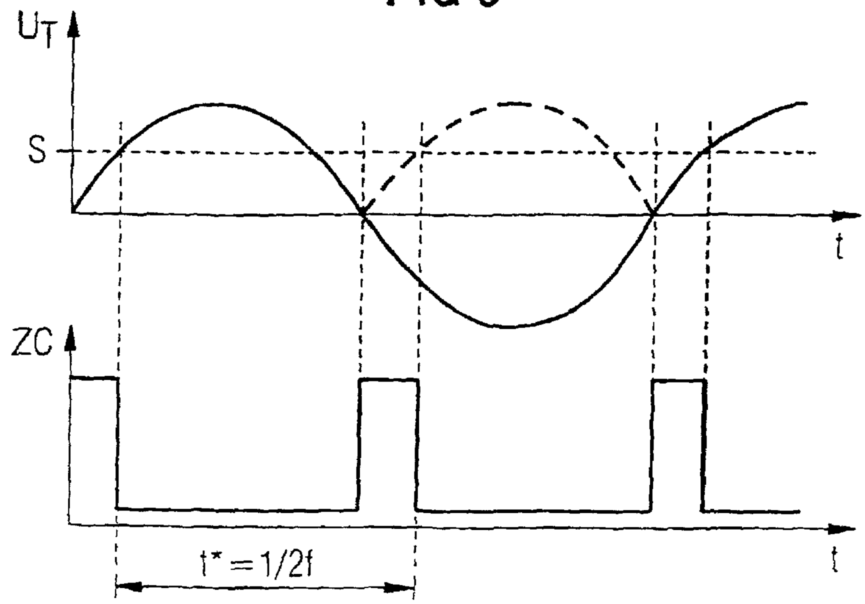


FIG 4

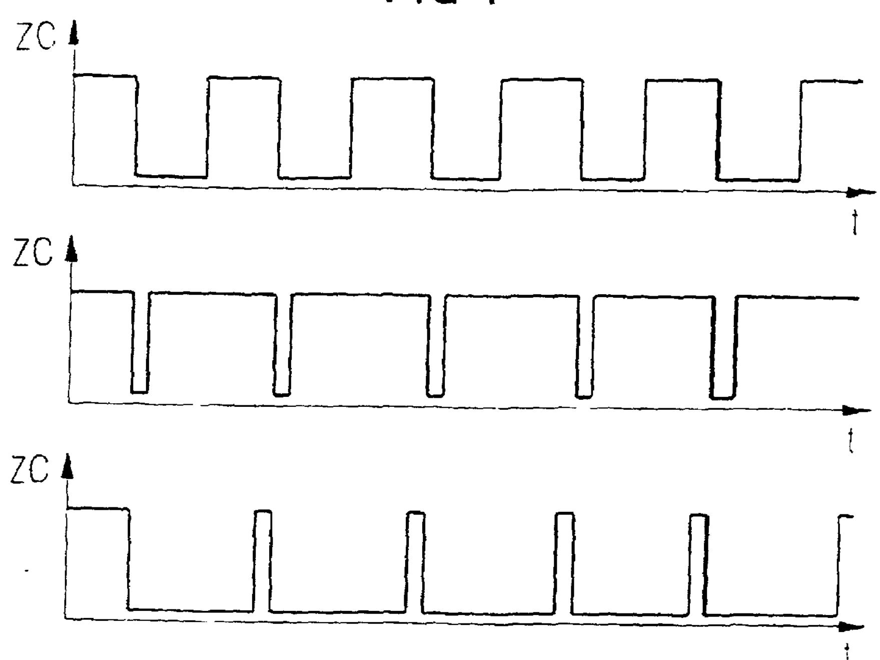


FIG 5

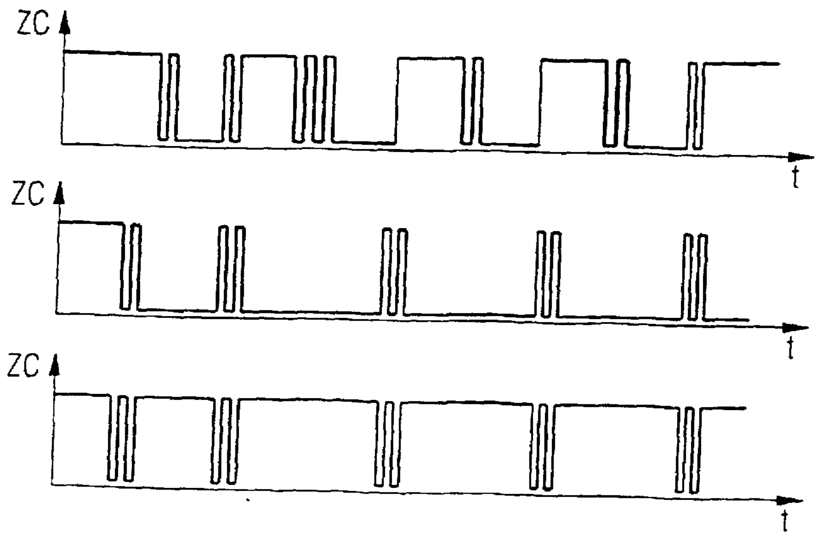
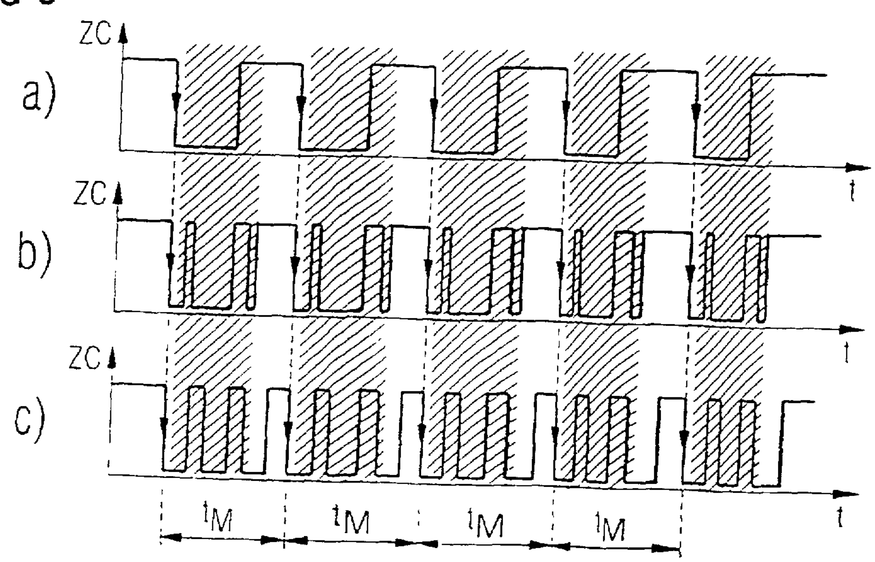


FIG 6



German Language Declaration

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Voller Name des einzigen oder ursprünglichen Erfinders: ARMIN MEISNER	Full name of sole or first inventor: ARMIN MEISNER
~~Unterschrift des Erfinders~~ Datum Armin Meisner 17.12.01	Inventor's signature Date
Wohnsitz RHEINHEIM, DEUTSCHLAND DEX	Residence RHEINHEIM, GERMANY
~~Staatsangehörigkeit~~ DE	Citizenship DE
Postanschrift LUDWIGSTR. 4	Post Office Addess LUDWIGSTR. 4
64354 RHEINHEIM	64354 RHEINHEIM

Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Unterschrift des Erfinders Datum	Second Inventor's signature Date
Wohnsitz ,	Residence ,
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Form PTO-FB-240 (8-83)

Patent and Trademark Office-U.S. Department of COMMERCE

10015855 . 010202

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

Number / Nummer	Country / Land	Day Month Year Filed / Tag Monat Jahr eingereicht	Yes / Ja	No / Nein
19930458.0	DE	02.07.1999	☒	☐
	-		☐	☐
	-		☐	☐

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D, M, Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
PCT/DE00/02021	21.06.2000	anhängig	pending

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

TONRUF-FREQUENZBESTIMMUNGSVORRICHTUNG UND -VERFAHREN

Device and method for determining tone ringing frequency

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 21.06.2000 als PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/02021
eingereicht wurde und am ______ abgeändert wurde (falls tatsächlich abgeändert).

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 21.06.2000 as PCT international application
PCT Application No. PCT/DE00/02021
and was amended on ______ (if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed: